



PLANETARY DEFENSE

Architecture for Mitigating Short-Term Warning Cosmic Threats: READI Project

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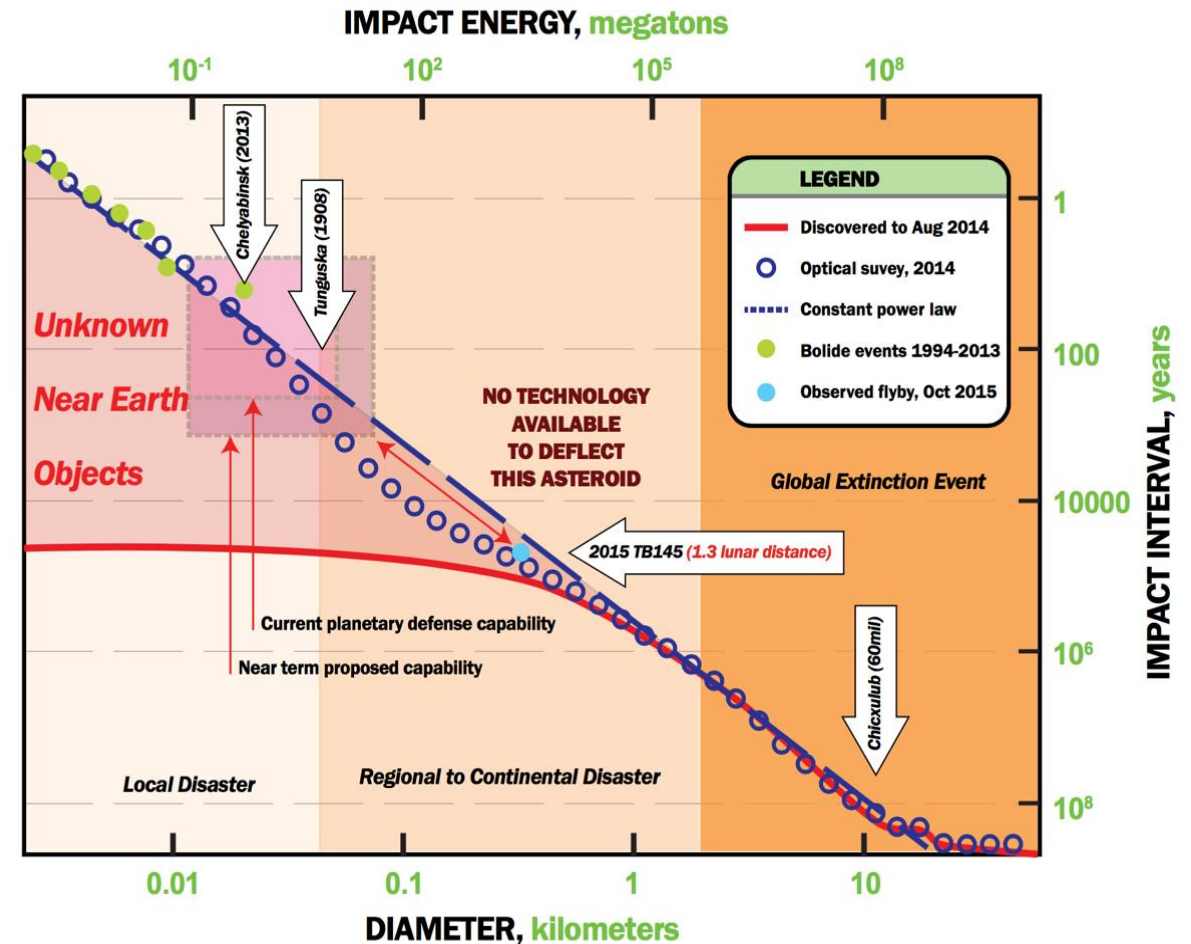
Outline

- Why do we want to defend our Planet?
- Background
- Problem Statement
- Key aspects of responding to a cosmic threat
- Conclusions & Recommendations

Why do we want to defend our Planet?

Identified Objects:

- Potentially Hazardous Objects (PHOs):
~1,590
- Near-Earth Objects (NEOs):
~12,500
- Comets:
~4,000 / ~1 trillion

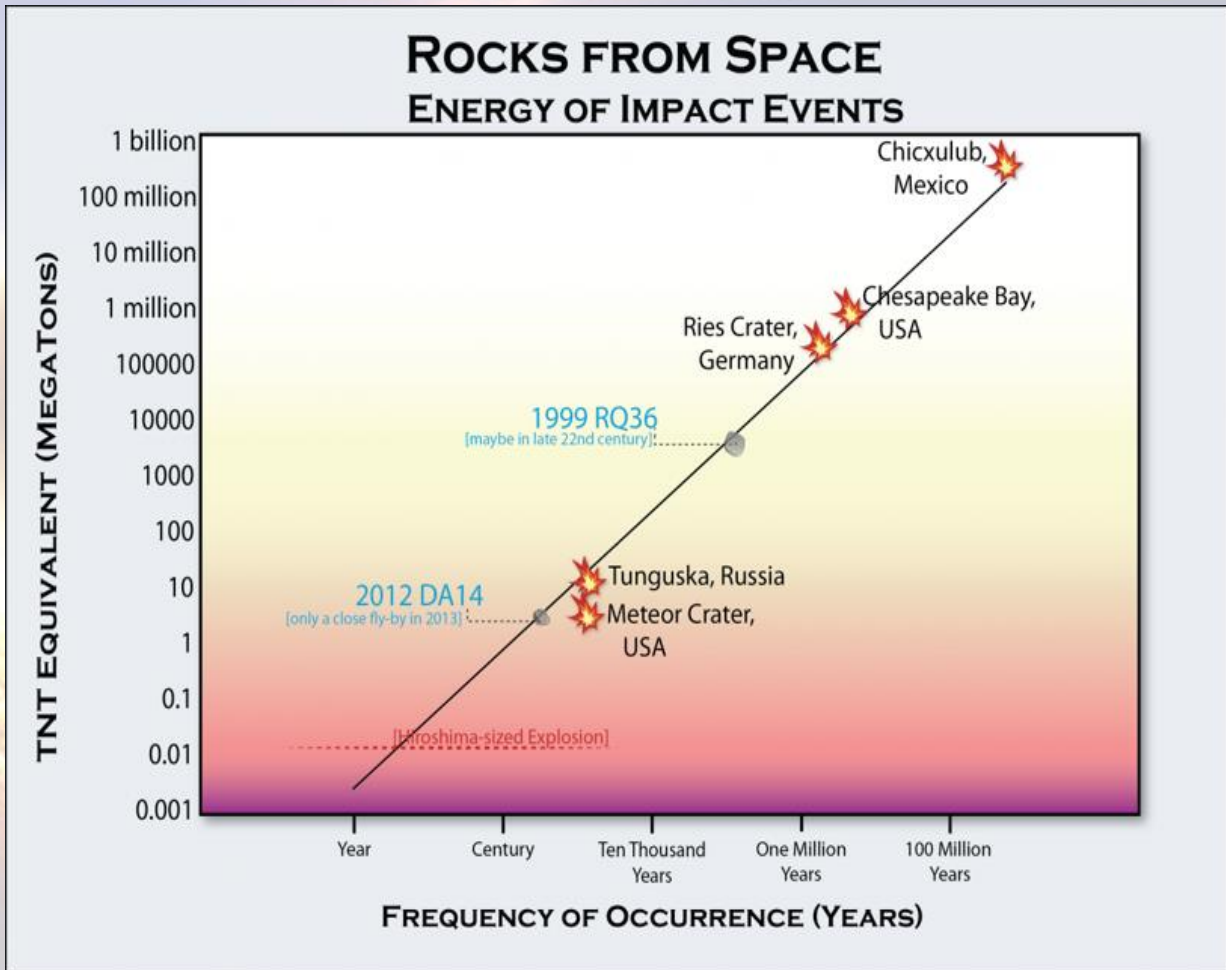
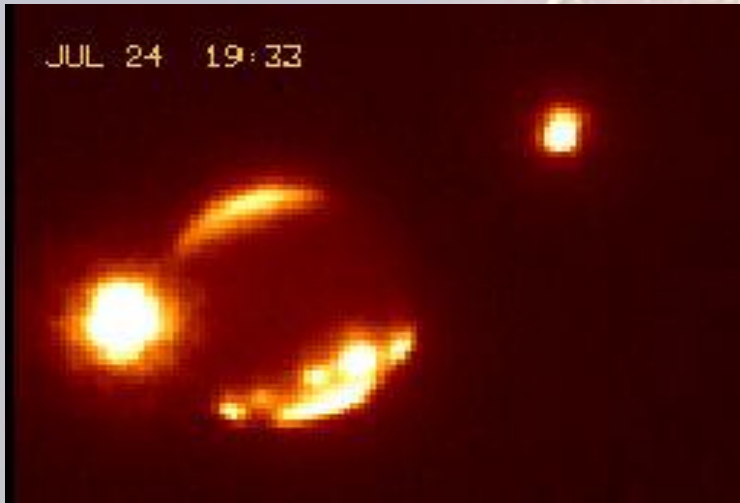


Plot redesigned and based on ref. no. 10 Harris, A.W.

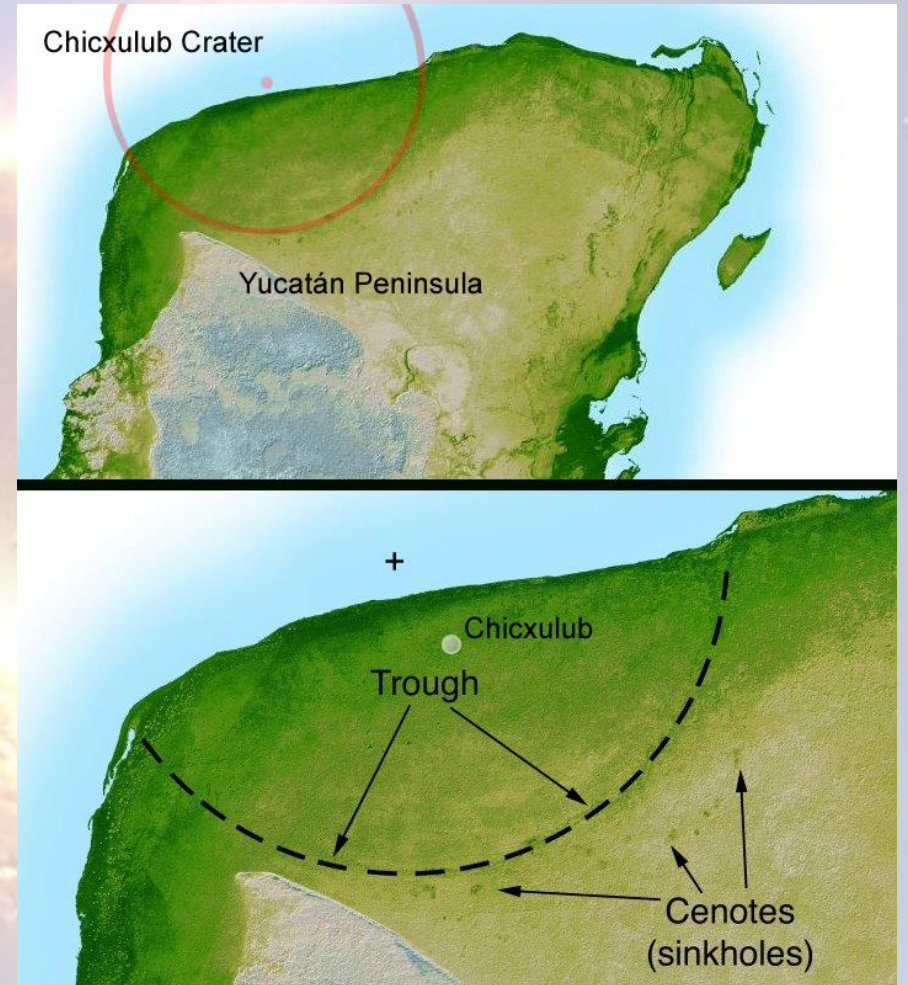
Background Information (Impact History)

Past Impacts (recorded):

- 1490 Ching-Yang Meteorite Shower
- 1908 Tunguska Event
- 1994 Shoemaker-Levy Comet
- 2013 Chelyabinsk Meteor



65 Million Years Ago...



2 Years Ago...



Why deal with this issue now?

- Chelyabinsk incident: temporary international attention
- Lack of attention to cosmic threats: limited funding
- Some potential solutions already exist: need to increase TRL and ORL of current technologies
- General public is sadly uninformed on cosmic threats

Threat Parameters

Threat Definition:

- Type: Comet
- Size: 800m diameter
- Composition: Ice dust
(water, methane, ammonia)
- Warning time: ~2 years
- Relative velocity: 36 km/s

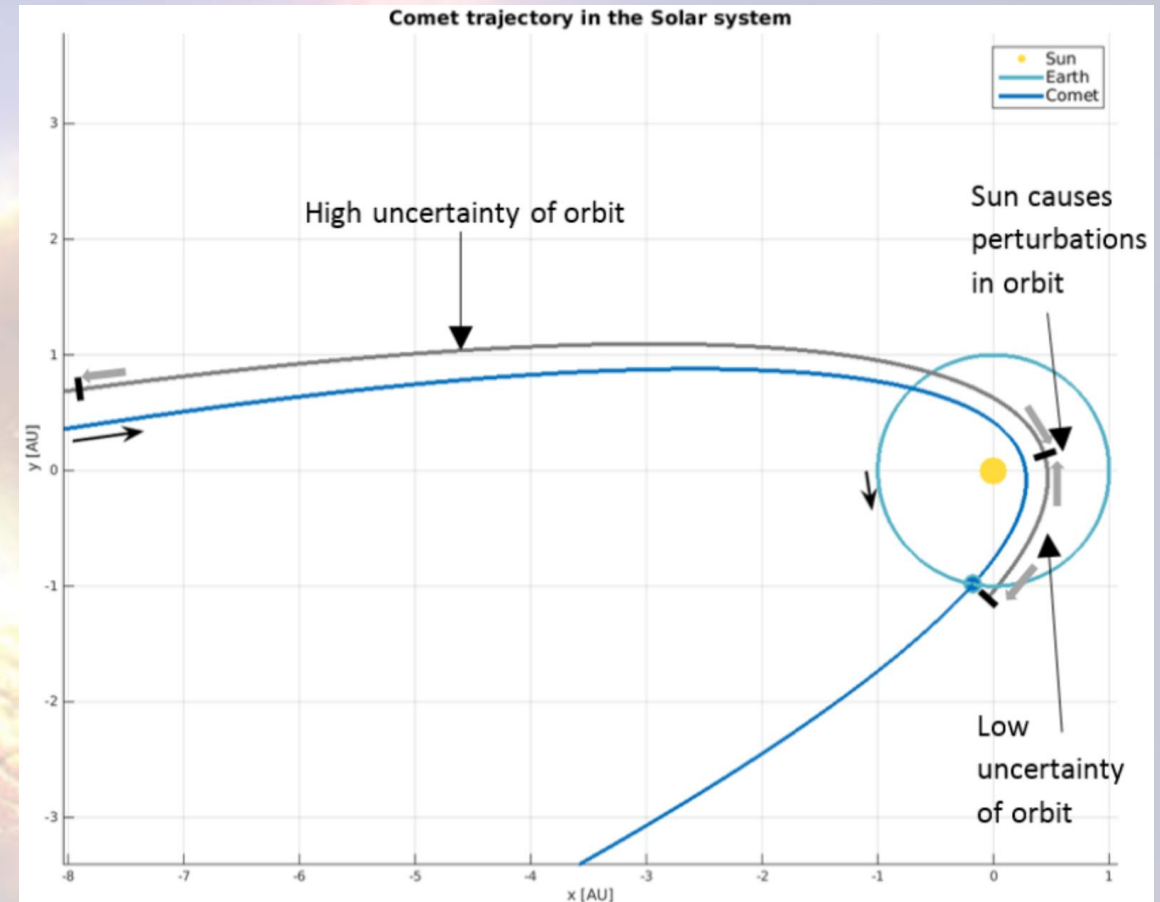
Orbital Parameters:

- Semi-major axis: 34.24 AU
- Eccentricity: 0.992
- Inclination: 174° to J2000 ecliptic
- Perihelion: 0.27 AU
- Aphelion: 68.15 AU
- Period: 200 years

Detection

Enable Advance warning

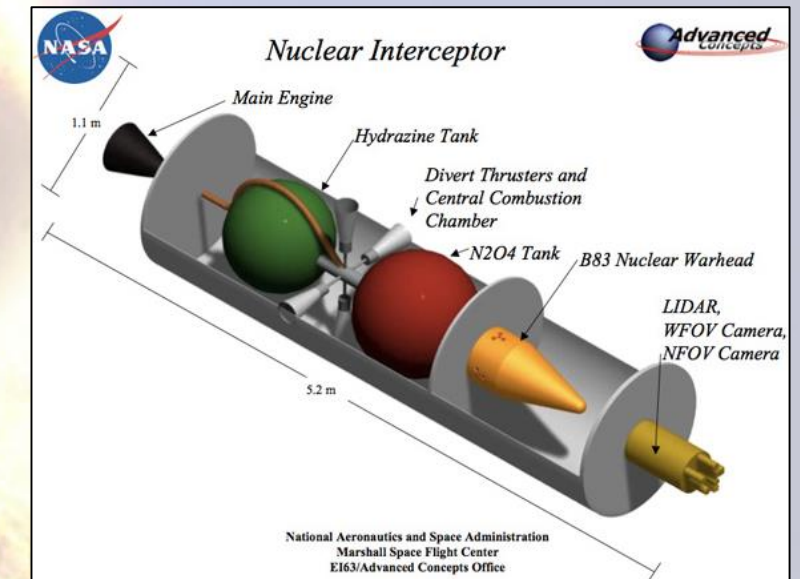
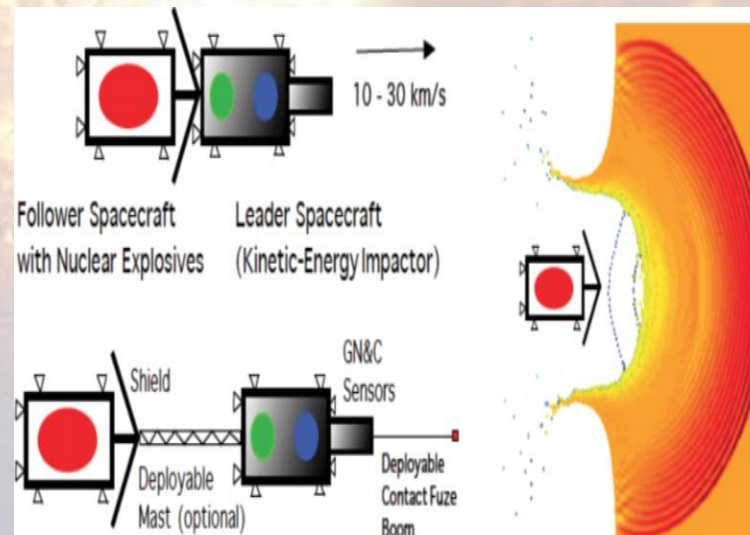
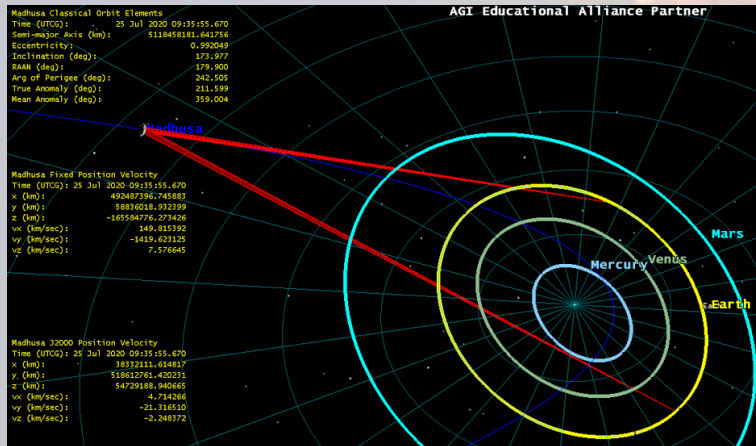
- Make space-based IR telescopes available
- More ground-based observations
- Increased sensitivity of detection
- Cover complete sky every night
- Increased Southern Hemisphere coverage
- Dedicated tracking network - amateur astronomers



Comet trajectory simulation using initial orbital parameters on MATLAB

Deflection

- Directed Energy Systems (DES): High power laser beams interacting with the comet from L4 and L5
- Hypervelocity Comet Impactor Vehicle (HCIV):
- Thermonuclear Energy Device (TED):



Policy Implications of a Cosmic Threat

- Planetary Defense technology is inherently dual use technology
- Responsibility to Protect (R2P)
 - Ground laid for R2P in UN report A/57/303, August 2002
 - Based on three elements
 - Responsibility to Prevent
 - Responsibility to React
 - Responsibility to Rebuild
- Responsibility to Defend (R2D)
 - Extension of R2P's elements to Planetary Defense
 - Responsibility to Detect cosmic threats
 - Responsibility to React to cosmic threats
 - Responsibility to Rebuild in the aftermath of a cosmic impact

Conclusions and Recommendations

- **Conclusions:**

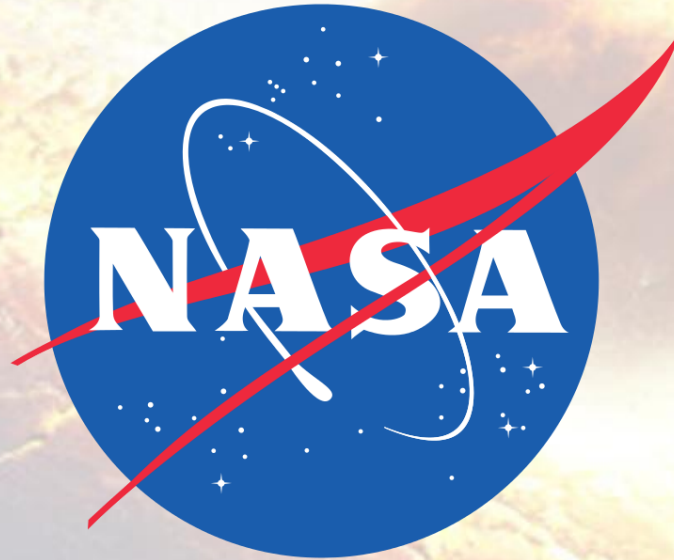
- Increase detection capabilities
- Develop, test, and validate deflection technologies such as:
 - DES
 - HCIV
 - TED
- Develop new policy norm: R2D

- **Recommendations:**

- Develop disaster preparedness strategies for cosmic impacts
- Increase public awareness



Acknowledgements



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